LARGE DIAMETER TURNTABLE WELL

NORMAN DALE, who submitted this article shortly before his death at the age of 78, needed a big turntable to cope with his 0–8–0 tender engines – so big, in fact, that the well was beyond his turning capacities. In typical style, he devised a hand-built well based on a small centre made in his metal-working lathe and cut out using a simple radius cutter. We pass it on here for the wider benefit, with special thanks to Norman's good friend Sid Stubbs, for his help in preparing these notes, and to Monty Wells, for making the drawings from rough sketches:

Some time ago, as a change from 24 years of locomotive building, I decided to get on with an L & Y layout before I got too long in the tooth. The baseboards for this layout were built a few years ago, track and points being built later and stored to await fitting. So, once a start was made on the actual layout, things just flowed along. That was, until I decided to build a well turntable.

A look through my modelling index showed all the articles on turntables written during the past thirty-odd years. I decided on one built in 1951 by Sid Stubbs for the Northchurch layout (*Model Railway News*, May 1960), which I've had the pleasure of operating for some time. The Northchurch table was based on one at Chinley (Midland Railway) which, I seem to remember, was built by Cowans Sheldon. As the L & Y also didn't build their own tables, I felt that a Cowans-built table would be suitable for my layout. An added advantage, should I become stuck, was that I could always 'phone Sid, a personal friend.

Sid's turntable well was turned on a wood lathe, but my table was to accommodate 0-8-0 tender engines, the biggest L & Y types, and so needed to be 11in long. If the bridge was to be that size, the well was going to have to be about 14in across—far too big for the average Myford lathe. I mulled over this problem for a few weeks until I recalled the time when I was required to cut very large, truly circular holes in plywood. This I did using a radius cutter—that's a bar pivoted at one end with a cutter at the other. I decided to build the well out of saw-cut sectors which, using a radius cutter at each stage, could be trimmed circular after fitting.

This article shows you how to build that truly circular turntable well in any scale from non-circular parts. The article largely ignores the turntable's bridge and method of drive, but bridge construction anyway followed Sid's original 1960 article, which I'm not going to repeat. Besides, a first-rate piece on Cowans Sheldon bridge practice, written by John Wright about his own model of a 50ft table, appeared in *MRJ* No 25. John's model also featured a lathe-turned well, so these notes should be of help to readers of that article who have no access either to a large lathe or to friendly turners.

You'll note in this article that details of the well depth and spindle height are missing from the drawings; the method works for turntable wells of any depth and, as mine is anyway in an imaginary situation, its exact depth is irrelevant. However, where dimensions are quoted, these are as I've used on my 4mm scale version; turntables in other scales would obviously benefit from larger or smaller dimensions, as befits their scale.

How you drive the turntable bridge is very much open to choice. Modern motor/gearboxes are excellent, and there must be at least a dozen ways to drive a bridge from them, several of which have been aired in *MRJ*. One way is simply driving the main shaft of the bridge by direct gearing from a gearbox, as I've done, although this admittedly fails to isolate the gearbox from any sudden bridge jerks or knocks. Another way would be with the motor/gearbox driving a shaft to which is attached a rubber wheel, the wheel friction-driving a circular plate attached to the bridge shaft. Alternatively, you could put discs with grooved edges on to both the bridge shaft and gearbox drive shaft and interconnect them with either a rubber band or, with the aid of a tensioner wheel, string. My drive coupling, which drives the bridge shaft below the well, is shown in *Fig 1*, being just two simple pins on a male face plate and a couple of closely matching holes in a female face plate.

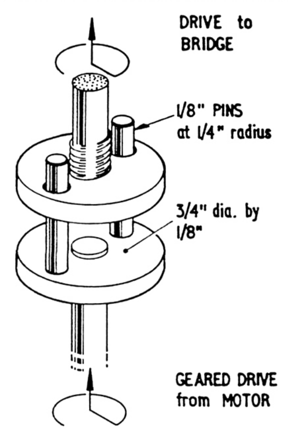


FIG 1
DRIVE COUPLING

Whilst modern motor/gearboxes are good, as I've said, it can really pay to keep your eyes open for old bargains. I used a drive which I bought Government Surplus years ago. It's an ex-RAF Type PU5 motor/gearbox having a 24V motor and integral reduction gearing—which is superb—and when driven by a transistorised controller, it can be reduced to a mere crawl, a half-rotation of the turntable taking as long as 123 seconds, which I feel is realistic. The price of this little gem was 12s 6d (62$\frac{1}{2}$p), so I bought a couple, just in case.

MATERIALS

Two types of wood were used on the well: $\frac{1}{2}$in thick ply for the base and American whitewood for the visible parts. The plywood had done 60 years service as the base of a trouser press and was perfectly flat. Being so old, I was confident that it wouldn't warp! This piece measured about 13 × 14in, quite sufficient although a complete square would have been preferable.

As for the American whitewood, any close-grain, old wood would have done. I used a type of whitewood called 'canary' because, at the time, I was in charge of a joiner's shop attached to the printing trade. Old canary making-up boards were being scrapped and, thinking only of the company, I carefully guided them into our shop. I soon had a lovely stock of bone-dry canary in various thicknesses down to $\frac{1}{16}$in. Other names for (and types of) American whitewood are yellow pine, Parana pine and basswood. Cedar can also be used, as can a good mahogany. Old wood is the best because, being dry and well seasoned, you can be assured it will not warp.

If you can't buy the wood in ready-planed thicknesses of $\frac{1}{8}$in and $\frac{1}{16}$in, you could buy thicker sizes and plane them down to suit. For this you'll need a good plane and a bench hook. What's a bench hook? See *Fig 2:* I can't imagine how anyone

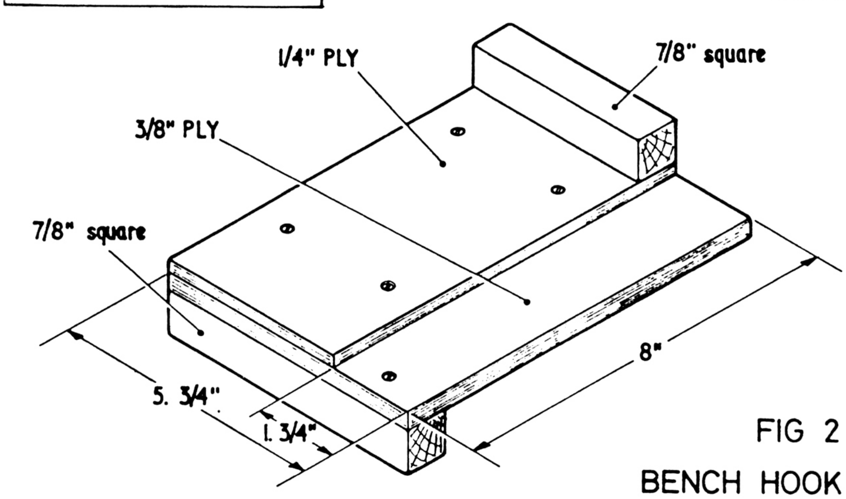


FIG 2
BENCH HOOK

can do carpentry without one. And when planing very thin wood, it helps (when you've found which way the grain goes) to clamp it down as *Fig 3*, planing away from the clamp. When its down to thickness at one end, turn the wood end-over-end and upside-down. This means that, although again planing away from the clamp, you are now planing towards the thick end *and* still planing with the grain. Done this way, you can get to almost paper thickness. We'll make joiners out of you yet . . .

THE RADIUS CUTTER

The radius cutter described below is critical to the entire accuracy of the turntable well. It must fit easily but without slop to the spindle, so that it rotates accurately. Its various holes and the peg of the cutting tool must be equally without slop, so that the cutter can be removed and refitted to a hole and take up exactly the same radius at the cutting edge as before. Finally, the cutting edge itself must be firm to avoid bending and so introducing radius errors, and both sharp enough and tough enough to make all the cuts without needing regrinding in between, as this, too, can introduce radius errors. That said, it's easy enough to make.

Arm: I used a length of $\frac{3}{4}$in × $\frac{1}{4}$in steel bar for the radius arm, this being solid and suitable for the purpose. *Fig 4* shows the tool dimensions required for my turntable well, these relating to the radii of the rail bed, rail centre, well wall and walk-way edge. If you're building a turntable to dimensions other than those I've used, bear in mind the need to alter the tooling holes on the radius arm to suit.

Having stressed the need for great consistency of cut—and without suggesting that accuracy of radii doesn't matter—if your holes are slightly out of position on the arm then you will simply cut a hole of slightly inaccurate size. That's possibly alright as long as the hole can be repeated exactly and is truly circular, and provided the inaccuracy doesn't cause either a foul or large gap between the bridge and the well. But to achieve repeatability of radius, each hole must be truly vertical in the bar and a dead fit for the silver steel cutter, so do take care. These holes are best drilled on a pillar or stand drill, if you have one, to keep them perpendicular. Each is then cross-drilled, the cross-drillings being tapped 6BA to accept a locking screw.

Cutter Blade: The cutter blade only takes about 10 minutes to make. It begins as a short piece of $\frac{3}{32}$in diameter silver steel, and is ground up to a V-shaped knife edge at one end. It cuts on its lower edge, not on its leading edge (as does a knife). Note that it's only the extreme end which is cut to a 'V', not the whole length of the cutter extension or it will bind as it cuts more deeply. The cutting edge is to be as thin as possible and yet be strong enough to do the cutting. This needs to be hardened and tempered (see below), and finally oil stoned to a really sharp edge. The chances are that the cutter's blade edge will not be exactly central in the tool's diameter, so find some way to mark it so that you always fit it the same way in the radius bar.

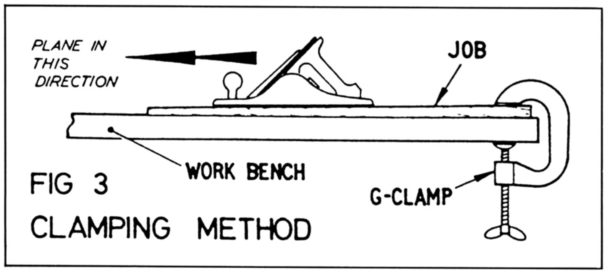


FIG 3
CLAMPING METHOD

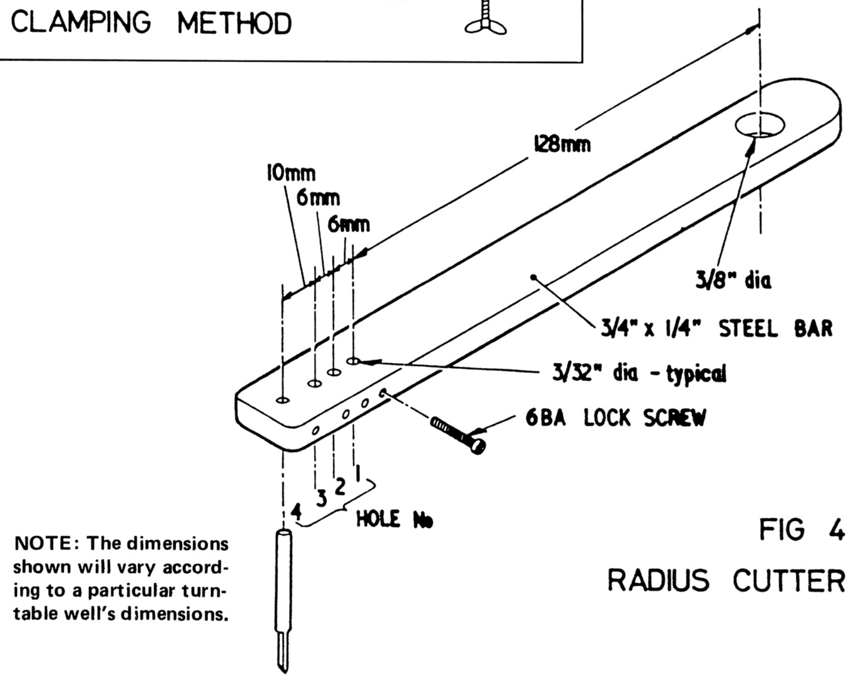


FIG 4
RADIUS CUTTER

Hardening and tempering is an easy two-stage process. After grinding the V-shaped knife edge, harden it by heating the whole cutter to cherry red, then immediately quench it in cold water. In this state, it's extremely brittle and so needs to be tempered before use. To do this polish the end back to bright metal and heat that until the tip turns to a deep straw colour (brown), then quench it again. For safety, protect the knife edge when not in use.

WELL SPINDLE

The well spindle is a key item as all the circular cutting is done from it. Here, I departed from Sid's article, making mine as *Fig 5*. Begin with $\frac{3}{8}$in brass rod and cut a $\frac{3}{8}$ BSF thread on for about $\frac{5}{16}$in. Drill and ream the rod $\frac{3}{16}$in to accept the table spindle. Don't assume that merely using ground silver steel will result in a perfect fit to the reamed hole; instead, check the fit of one against the other as you proceed. Mine needed

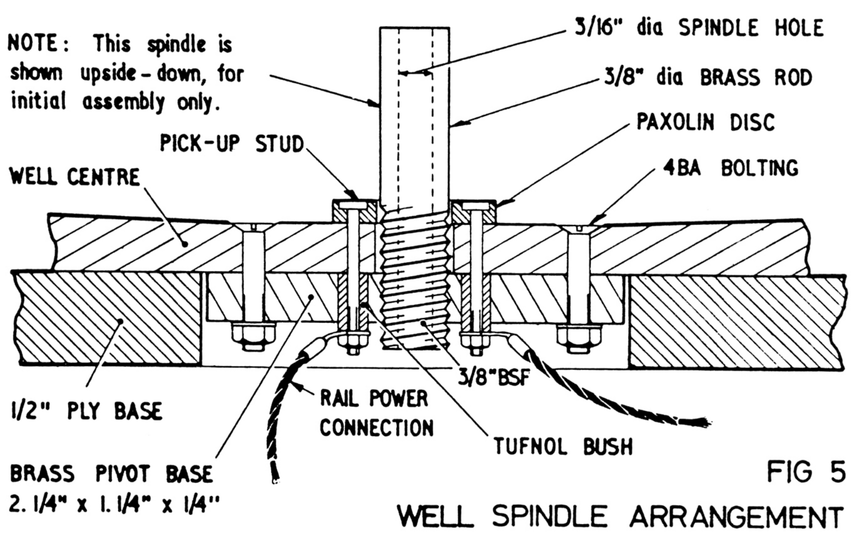


FIG 5
WELL SPINDLE ARRANGEMENT

a few passes with the reamer before the table spindle moved smoothly within the well's brass spindle.

For the spindle base, you'll need a 2$\frac{3}{4}$in by 1$\frac{1}{4}$in piece of $\frac{1}{4}$in brass, mine coming from the scrap bin. Find its centre and pop it lightly. Grip it in a four-jaw chuck on the lathe and adjust its position until the centre pop is dead centre, which can be checked by a quick spin of the lathe when the centre pop should 'stand still'. Using the lathe tools, lightly scribe a $\frac{5}{8}$in pitch circle line around the pop mark. Still in the lathe, drill and tap the centre for $\frac{3}{8}$ BSF. The $\frac{5}{8}$in circle line is for two later holes at 180° and insulated to take the rail feeds to the table. Before removing the base from the lathe, use the lathe tool to pass a faint mark lengthways across the face of the base plate and another, a circle, close to the edge of the base for the positions of the fixing screws. As I've said before, a lathe is not just for turning things—it can be accurate whilst saving time and patience when marking out.

After removing the base from the lathe, drill four holes for the fixing screws; I believe mine were to clear 6BA screws. The two holes for the insulating bushes on the $\frac{5}{8}$in circle can also be drilled, this time at $\frac{3}{16}$in. Insulating bushes $\frac{5}{16}$in long are turned up from Tufnol at $\frac{3}{16}$in diameter with a 6BA clearance hole.

Now is the time to make the Paxolin disc, Tufnol bushes and pick-up studs as shown at *Fig 6*. Although not a part of the turntable well, it's a good idea to make the bridge pivot bush and bridge pick-ups at this stage. The bridge and well are joined by a pivot of $\frac{3}{16}$in silver steel running between the well's pivot and the bridge's bush; these are shown at *Fig 7*, and remember that the bush must be at the precise centre of the bridge construction. If it isn't, the bridge will run eccentric within the finished well and foul the edge. When installed properly in the turntable well, the well spindle will project downwards with the pivot spinning within it. However, because we want to use the spindle as the pivot for the radial cutter, the spindle should, for now, be assembled upside down (pointing upwards, as shown at *Fig 5*).

THE WELL CENTRE

The wooden centre of the well is shown at *Fig 8*; you'll see it's octagonal and measures 4$\frac{3}{4}$in across its greatest span. This will mount the well pivot and provide the interface to the eight sections of well floor. Its thickness tapers from $\frac{1}{4}$in at the centre to $\frac{5}{16}$in over *all* the chord edges, not continuously tapering to its extreme diameter. If it were to do this, the chord would be of varying section and would show a stepped joint to the well floor sections. Using simple wood-turning tools, this was made from canary on my old EW lathe, fixing a piece of $\frac{7}{8}$in rough-turned wood to the lathe face plate to act as a pad.

The well centre was roughly cut to shape and, using panel pins, tacked securely to the pad. My EW has only a 2$\frac{1}{2}$in centre to its bed and the coarse-cut well centre came close to that. Rather than risk injury or tool damage by having the well centre strike the bed while turning under power, the first trimming work was done by hand-spinning the lathe—positively no power! First, pencil a line to show the diameter required intact, then

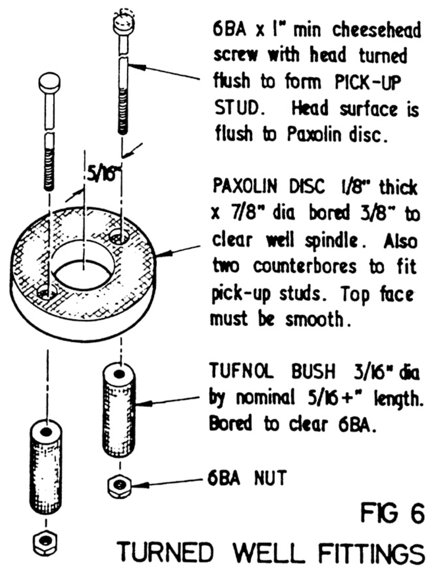


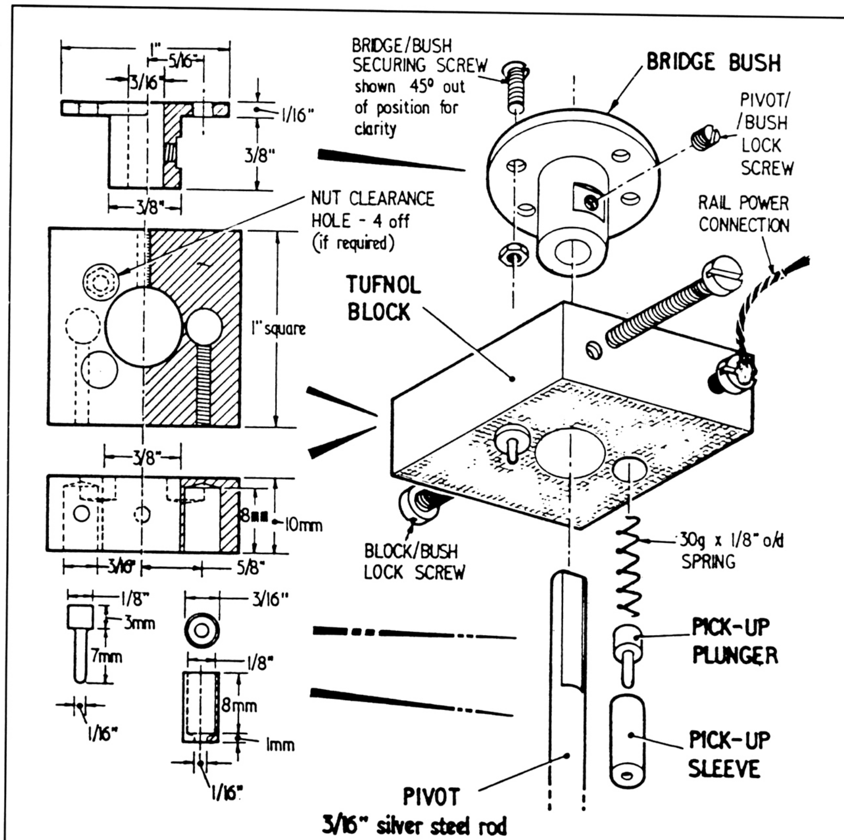
FIG 6
TURNED WELL FITTINGS

use a chisel and coarse file to remove all high spots. Only when satisfied that the job will not strike the tool bed should you use the lathe's motor. Clean the face only, then pencil another line on the pad to show the position of the job's edge on it. Remove the job from the pad and, using the pencil mark on the pad, reverse and secure it into the same location, showing its coarse face. Recheck that it doesn't foul the lathe bed and then take both the edge and face to their finished sizes and lathe-drill a $\frac{3}{8}$in diameter hole through its centre. Leaving the job in the lathe and, using a suitably toothed gear wheel on the mandrel end, divide and pencil-mark the edge of the job into eight equal parts. Now you can remove the job from the lathe and join the nine dividing marks (which you should have) to form eight chord lines to be cut. Using a tenon saw, cut the eight little segments off the edge and, using a sharp block plane, trim them to the line leaving them clean and square. That's all the wood-turning needed on this turntable well.

THE WELL BASE

We've reached the stage where we assemble the well spindle assembly and well centre to the base, the assembly being shown at *Fig 5*. The base carries the whole of the turntable and is of $\frac{1}{2}$in ply. As I've said, my ply was a 13in × 14in rectangle, its corners securing the finished well to the layout's baseboard.

Begin with a $\frac{3}{8}$in diameter hole drilled through the centre of the plywood base. Offer up the well spindle assembly and mark out and cut a rectangular hole to clear the spindle's base. Next, fit the spindle assembly into the octagonal well centre, securing it with at least four countersunk bolts, the bolt heads being in the top face. Now offer up the well centre and spindle assembly to the well base and, using a pencil, mark the edge of



Drawing developed from May 1960 Model Rly News, S Stubbs.

FIG 7
BRIDGE FITTINGS

the well centre on the well base. Lightly coat only the surfaces where the well centre meets the base with a little PVA glue and assemble the lot, tacking the well centre to the ply with a few panel pins.

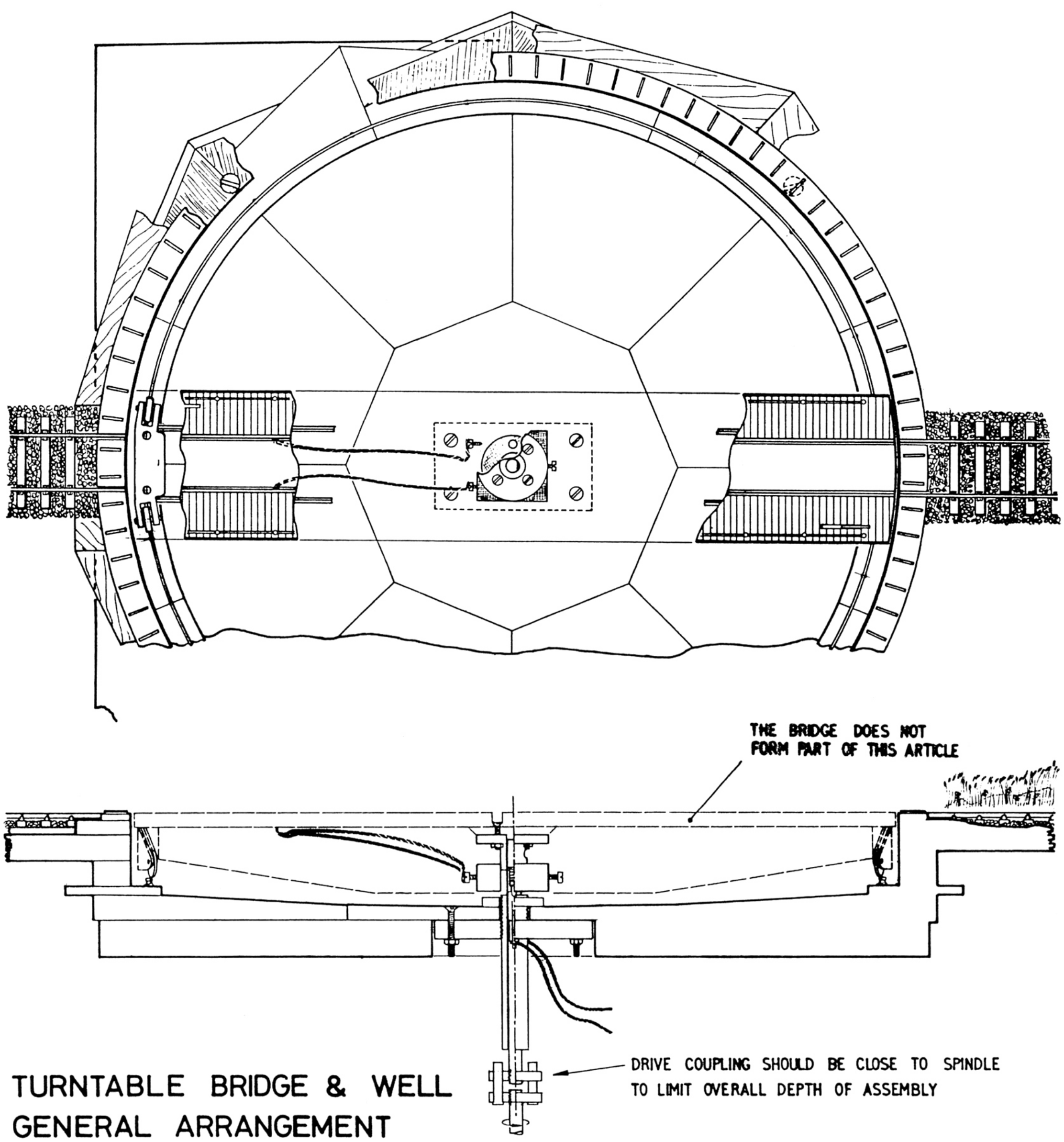
The countersunk bolt heads should never see daylight as they're close to the centre of the well and the bridge centre hangs low towards them. But prototype turntable bridges differ and, if you're worried that yours will show, they can always be filled proud with a mixture of canary sawdust and PVA glue, later being glass-papered down to an almost undetectable finish. Other proprietary fillers will do.

THE WELL FLOOR

The well floor is closely-fitting strips of canary wood fanning out from the octagonal well centre. Because the well floor is not horizontal but is shallower at the outside edge, the well floor strips must taper not only in the lateral plane but in the longitudinal plane also. At least, they taper until they meet the rail bed, where they must be truly horizontal. This taper can't easily be avoided by packing below the floor rim to lift it because, unavoidably, the outside top edge of the well will not be level, so the well won't fit the baseboard. Good tools and a little patient practice will make a good job of it for you.

Each well floor strip was prepared as shown at *Fig 9*, the inner edge tapering down to a $\frac{5}{16}$in thickness to match the octagonal well centre. For my well, each strip needed to be $4\frac{1}{2}$in square but, if your well is a different size, a few minutes making paper templates will quickly show the sizes yours will need. Begin by planing the taper on a long piece of canary, then cut that into eight squares (best have room for a couple of spares). To cut the radial edges of these and later sectors, I would advise readers to make a mitre box. There'll be 64 mitres needing cutting, so a mitre box will save both time and waste. Each radial line runs at 67.5 degrees from the parallel long and short edges of the sector, so the mitre box cuts across at the complementary angle of 22.5 degrees. Your cutting and mitre box accuracy should be as close to this as possible and you'll find you get better for a little practice. Save the sawdust—it comes in handy as a filler.

Take the eight pieces and mark and cut the mitre at one end of each, being certain that there's enough material left to cut the other mitre later and that the mitre runs the right way relative to the taper. Lightly clean up these cuts (without affecting their alignment) using blocked glass-paper. Assuming you've only one cutting line in your mitre box, take one piece and carefully mark it for its second mitre cut. Put this into the mitre box (upside down to the last cut) and cut that second edge very accurately. Then, using that sector as a template, nail a couple of small pins into the mitre box as alignment stops for the other sectors. Lift out the fully cut sector, then make



TURNTABLE BRIDGE & WELL GENERAL ARRANGEMENT

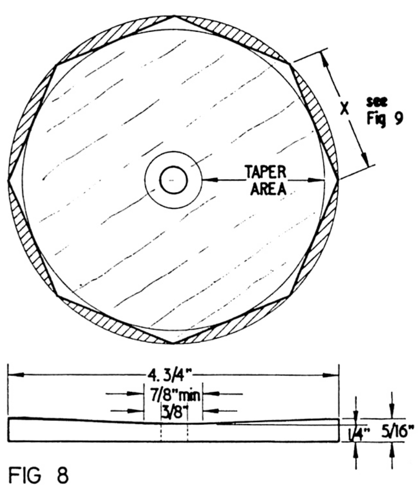


FIG 8
WELL CENTRE

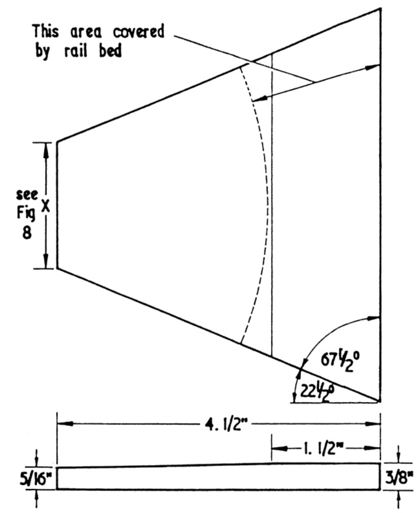


FIG 9 WELL FLOOR SECTOR

the second cuts on the other seven, the pins aligning them for you (saves a lot of marking out and errors). Finish these also with a light clean up.

After a dry-fit of all the floor pieces, glue and pin them into position (see *Fig 10*) and leave for 24 hours. Using blocked glasspaper, clean up the flat, outermost area of the well floor. Using glasspaper only, clean up all the segment joints, filling any gaps using sawdust/PVA filler.

RAIL BED

We first need to mark a line on the well floor indicating the edge position of the rail bed (Detail B on *Fig 10*). Before fixing the cutting blade in the radius arm, temporarily fit the radius arm over the well spindle and add some $\frac{3}{8}$in washer packings between the radius arm and the well floor to bring the two reasonably parallel to each other. With the cutter fixed in its No 1 hole and the radius arm slipped over the spindle, lightly swing its full diameter to mark the faintest line in the well bed. This line should be just hidden when the rail bed sectors are fitted, but will reappear after radius cutting!

The rail bed is made from $\frac{1}{8}$in thick canary (or whatever material you're using). It is laid, like the well floor, as eight separate sectors, each cut in the mitre box and thankfully without any taper of section. The major difference here is that, when laid, the inner edges of these sectors will be cut back using the radius bar. Their initial size, before the mitres are cut, must take into account the initial overlap that their inner edge needs. So with that in mind, cut out the eight required pieces to the size needed by your well. Again, when one piece is cut both sides, a couple of panel pins in the mitre box will act as accurate guides for the subsequent pieces.

Next, glue and pin these sectors in position, with their edge joints staggered relative to the well bed joints below; the glue will need at least an hour to set firmly. The inner edges of the rail bed sectors must, however, remain free of glue and pinning, because they have to be cut away next. So, with the cutter still in its No 1 position, start swinging the radius cutter round to gradually cut away the inner edge. Taking a little time, because there's no sense in cutting too quickly and smashing the edge or blunting the tool, it should leave a perfectly cut circle. The rail itself will be fitted after the well wall is installed.

WELL WALL

Long, heavy locomotives mean deep turntable bridges which, in turn, means deep turntable wells, yet my baseboard surface is thinner than most. To get sufficient depth for the well beneath the baseboard, I had to include another layer of canary wood as a below-board well wall (Detail C on *Fig 10*). Now, it may be that, if your baseboard is thicker and your bridge shallower, you won't need this extra piece. Conversely, if your well is to be mush deeper than mine, I suggest that, rather than using a very thick layer of wood as its wall, you use two or more thinner layers, cutting, laying and trimming each layer in turn. Having mentioned that the baseboard surface contributes to the depth of the well wall, I'd better warn that the radius cutter won't cut chipboard too successfully. If your baseboard is made of that, you may need to replace the local baseboard surface where the well is to fit, using ply instead. The following describes the construction of an additional, single layer, well wall:

Move the cutter to the No 3 position and mark a faint line on the newly-laid rail bed, the line marking the edge of the well wall. Cut eight wall sectors, each about 2in wide. Following the same procedure used on the rail bed, glue and pin them down with their joints staggered relative to those of the rail bed. When dry, with the cutter at the No 3 radius, swing the radius bar and trim the inner edge of the well wall to another perfect circle, perfectly concentric with that of the rail bed.

FITTING THE WELL RAIL

Re-adjust the washer packings and cutter for a faint cut on the rail bed at the No 2 cutter position; this marks the centre line of the well rail. Using bow compasses and a pencil, divide the rail centre line into however many securing positions you think your well rail will need (be generous). It just so happened that the first time I tried this, mine divided into exactly twenty marks, which was good enough for me! At each marked position, drill a pilot hole and fit a $\frac{3}{8}$in x No 2 brass countersunk screw to each, getting the screw head level with the rail bed surface.

The thought of bending flat-bottomed rail by hand to a consistent, tight radius didn't appeal to me, so I used a rail-bending machine I built from drawings in the September 1957 issue of *MRN*. Those of you who don't have such a thing can always use Sid Stubb's method, which I'll describe briefly here. Sid uses a sheet of stiff card or light ply, drilled with a $\frac{3}{8}$in hole in the middle (for the spindle). He then uses the radius cutter

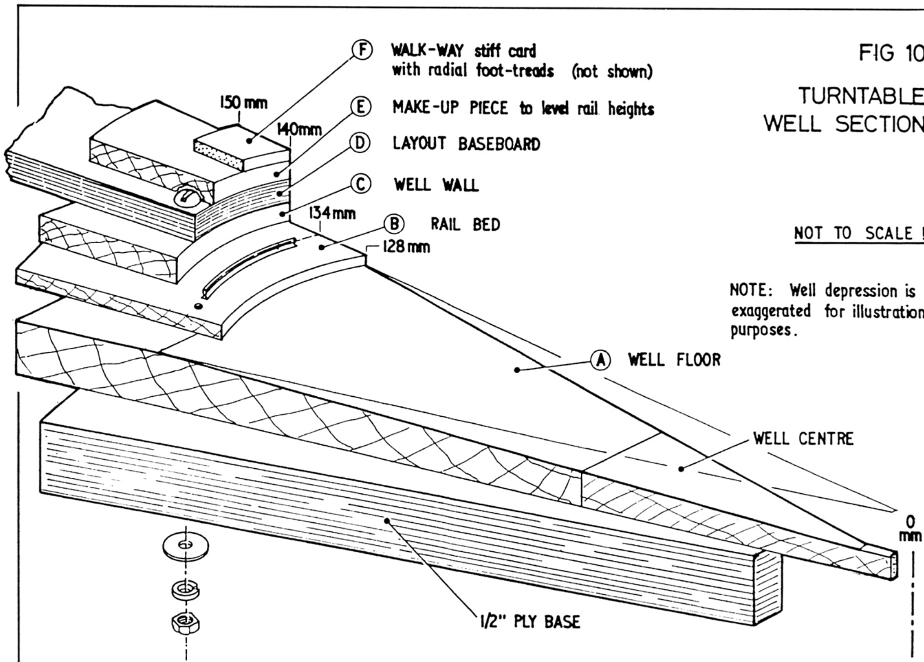


FIG 10
TURNTABLE WELL SECTION

to cut its outer diameter to the same diameter as the well rail centre line. When it's placed over the spindle, he then hand-bends the rail and solders it down, using the card or ply as a template. If you haven't got a rail-bending machine, this seems like a good method.

Whichever way you're going to bend the rail, tin the screw heads and the rail's underside (not at the extreme ends) and solder it to the screw heads. I began soldering the rail in the middle of its length and soldered a rail joiner between the two ends—not over a screw because the joiner would have lifted the rail at that point. You might prefer to arrange the joint to occur on a screw head and start soldering from there—it makes the rest of the soldering rather difficult but means that you can omit the rail joiner.

INSTALLING THE WELL ASSEMBLY

My baseboard surface was wholly intact where the turntable was going to be, and I'd ensured that there would be no below-board bracing to get in the way! Mark on the board surface the exact centre where the turntable well will fit and drill a $\frac{3}{4}$in hole there. The well assembly is held up to the underside of the layout surface, its protruding $\frac{3}{8}$in pivot shaft enabling you to roughly centre it in the $\frac{3}{4}$in board hole. From the underside, drill four $\frac{3}{16}$in fixing holes through the layout surface, through all the sectors and through the $\frac{1}{2}$in ply turntable base; these holes must obviously be somewhere around the outside edge of the hole diameter you're about to cut, otherwise you'll cut the baseboard hole and find the lot on the floor! After bolting it all together, you should have a turntable that is the right way up but underneath and covered by the baseboard, and with its base pivot still wrongly pointing upwards and protruding through the $\frac{3}{4}$in hole. You're now about to cut the turntable's hole in the baseboard.

Fix the cutter into the No 3 hole and pop it over the spindle protruding through the baseboard top. Swing the radius bar around and, gradually, the hole will be cut as smoothly as if on a lathe and a perfect match for the inner diameter of the turntable's well wall. Carefully lift out the cut circle and the turntable well is already in position—but don't reverse the spindle yet.

You'll see on *Fig 10* that there is a surface lap (Detail E) around the top surface of the turntable. This was necessary to match the depth of carpet tiles I'm using as a track bed; you may need to add one yourself. It's easy enough to do using the foregoing sector procedures. I didn't bother to trim the outside diameter of this lapping because it will be covered by track and scenery.

THE WALK-WAY

The walk-way, where the locomotive crew would walk when pushing the turntable bridge by hand, I made from stiff card of suitable thickness. You might prefer to cover this with some surface texture, such as fine glasspaper, or you could even use one of the new paving finishes in plastic—it all depends on your prototype. Whichever, card or plastic, it can be laid in sectors and both diameters cut using the No 3 and No 4 holes in the radius cutter. This done, the radius arm was put away and, at last, the well spindle was reversed into its proper arrangement, pointing downwards. All that remained to finish the well was to attach strips of wood on the path surface radiating from the well centre. These were used as foot-grips for the unfortunate fireman trying to push around an L & Y 0-8-0 on an icy morning!

After making the turntable bridge as described in Sid's article and installing same in the well, it turned round perfectly, just missing the well wall by about $\frac{3}{32}$in. Now that really is a joy to behold.

The Terrier, dwarfed in the centre of the bridge, shows that this is the sort of large-diameter turntable that can cope with anything. But with sub-surface tables, the bigger they are, the harder they are to model. This is Sid Stubbs's 80ft Cowans Sheldon table -- exactly the same as the one described by Norman Dale here. The signs of wear can be explained by the fact that Sid built this in 1951! SID STUBBS